In re Patent Application of:
DENYER ET AL.
Serial No. **09/891,134**
Filing Date: **JUNE 25, 2001**

REMARKS

The Examiner is thanked for his thorough examination of the present application. Independent Claims 12, 16, 21 and 26 have been amended to more clearly define the invention over the cited prior art references. No new matter is entered and it is believed that no new issues are raised by this amendment. Accordingly, favorable reconsideration is requested in view of the arguments present below.

I. The Amended Claims

Independent method Claim 12 has been amended to clarify that the second period of time is defined as being since the prior reset and that it overlaps the first period of time, and that the second output represents the cumulative signal during the second period of time since the prior reset and overlapping the first period of time. Independent device Claim 21 has been similarly amended to Claim 12.

Independent method Claim 16 has been amended to clarify that the first time period is since the prior reset, and that the first output represents a cumulative signal during the first period of time since the prior reset. Independent Claim 26 has been similarly amended.

II. Claims 12-15 and 21-25 Are Patentable

The Examiner rejected independent Claim 12 over the Dierckx et al. patent, and rejected independent Claim 21 over the Dierckx et al. patent in combination with the Hurwitz et al. patent. Firstly, the Dierckx et al. patent on column 2, lines 47-50 discloses an active or passive pixel structure such that with one single pixel, a double or multiple linear

voltage-to-light response can be obtained. The collection of signals between successive resets disclosed in Dierckx et al. differs from the first and second outputs of the claimed invention which are read between successive resets. Dierickx et al. discloses that while acquiring charge on the output node of a photosensitive element, creating a first signal after a first time period, creating a second signal after a second time period; and then combining the first and second signals to form a readout signal. In column 3, lines 20-21, Dierickx et al. provides that the collected signals form "two charge packets, each obtained during a different time". In other words, a first charge packet is obtained during, or through the course of, a first time period and a second charge packet is obtained during, or through the course of, a second successive time period. The first signal is stored on a memory element, while the second signal is read directly from the output node of the photosensitive element. This is in sharp contrast to the present invention.

Specific embodiments in Dierickx et al. are discussed from column 5, line 26 to column 7, line 56, with reference to FIGS. 1-5. The signals which drive and read a pixel are discussed from column 6, line 55 to column 7, lines 49. In the embodiment discussed, sample A represents a sample taken after a first period of time within the integration period, corresponding to the first charge packet. At another point in the integration period, sample B is taken, which corresponds to the second charge packet. The sample B is referred to sometimes as representing the "recent potential" on the photodiode, and at other times as being "in itself the average of the potential on the capacitor C and on the

photodiode" (see col. 7, lines 14-16). In either case, the first sample (sample A) is meant to represent an electrical response with low sensitivity, while the second sample, sample B, is meant to represent an electrical response with high sensitivity (see column 7, lines 13-17).

As the Examiner is no doubt aware, light that has a very high intensity or brightness means that a high number of photons are incident on a photosensitive element per unit time. If an integration period is set too long, the image sensor becomes saturated, that is, the number of photons that are incident on the photosensitive element becomes too large and overwhelms the capacity of the photosensitive element. Detail of an image is therefore lost. However, if the integration period is kept short, then a smaller number of photons will be incident on the photosensitive element, and the detail of a bright scene can be retained. Similarly, light that has a very low intensity or brightness means that a low number of photons are incident on a photosensitive element per unit time. If an integration period is set too short, there may not be enough photons incident on the photosensitive element to generate enough image data. Therefore, a longer integration time is sensitive to low light levels. An image sensor with a high dynamic range can image a scene across a wide range of brightness.

In Dierickx et al., sample A is obtained after a relatively short period of time, and so that image data represented by sample A is sensitive to high intensity light. This charge is then stored on a memory element provided as a specialized part of each pixel. Charge then continues to be built up on the photodiode and then sample B is taken at the

end of the integration period. This charge packet contains the charge that has been accumulated since the time of sample A up until the time of sample B. Because this time is longer than the time from the start of the integration period until the time of sample A, sample B represents an image which is relatively sensitive to low intensity light. The two signals are then combined to form a resultant read-out image.

In contrast, a first output of the present invention reads the signal that has been accumulated from the beginning of the cycle to the read point without destroying, that is transferring, the cumulative charge. The second output that is read also reads the cumulative charge that has built up from the beginning of the integration cycle including the charge read out in the first signal. The first output and the second output are then combined to obtain a resultant set of image data having a dynamic range different from the first and second dynamic ranges. This does not require the presence of a dedicated memory element for each pixel as is seen in Dierickx et al. patent.

Because the first and second outputs that are combined both refer back to the beginning of the charge collection, it is clear that the increased dynamic range sensitivity given by the present invention is different from the increase in dynamic range sensitivity that may be given by the Dierickx et al. This difference gives a clear improvement to the invention over Dierickx et al. When brightness extremes for a basic image are considered, the approach of Dierickx et al. may provide an improvement, because a very bright area of an image will only be properly imaged in either sample A or sample B. However, for a bright portion of an

image that is on the borderline between being properly imaged by sample A or sample B, the way in which Dierickx et al. separates the charge means that some information is lost, and so there is a lack of sensitivity. The data provided by the first and second outputs of the present invention, where both outputs are a cumulative measure, provides more information that a processor can use to correctly combine the images.

The Examiner helpfully refers to FIG. 5 of Dierickx et al. patent. This figure purports to show the potential level seen on the photodiode output node and on the node C on the third line in the diagram (col. 6, lines 55-58). This shows a signal level that decreases linearly between successive resets. However, it is submitted that this figure does not show the cumulative or non-destructive type of read operation as in the claimed invention.

The Hurwitz et al. patent adds nothing to deficiencies of Dierickx et al. Accordingly, it is submitted that independent Claims 12 and 21 are patentable over the prior art. In view of the patentability of these independent claims, it is submitted that their dependent claims that recite yet further distinguishing features of the invention are also patentable and require no further discussion herein.

III. Claims 16-20 and 26-31 Are Patentable

Independent Claims 16 and 26 have been similarly amended to each other. In particular, Claim 16 has been amended to clarify that reading a first output from each pixel after a first period of time is since a prior reset, and to further recite that the first output represents a cumulative signal during the first period of time since the prior reset.

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The Examiner rejected independent Claim 16 over the Dierickx et al. patent and rejected independent Claim 26 over Dierickx et al. in combination with Hurwitz et al.

The Examiner points to FIG. 5 and interprets the sample pulse as being the immediate reading of a preliminary output. Applicants respectfully point out that the sample pulse merely begins the integration process and is in no way the immediate reading of a preliminary output as recited in independent Claims 16 and 26. Hurwitz et al. adds nothing to this critical shortcoming of Dierickx et al. Accordingly, it is submitted that independent Claims 16 and 26 are patentable over the prior art. Their dependent claims that recite yet further features and advantages of the invention are also patentable and require no further discussion herein.

IV. CONCLUSION

In view of the amendments to the claims and the arguments provided herein, it is submitted that all the claims are patentable. Accordingly, a Notice of Allowance is requested in due course. Should any minor informalities need to be addressed, the Examiner is encouraged to contact the undersigned attorney at the telephone number listed below.

Respectfully submitted,

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